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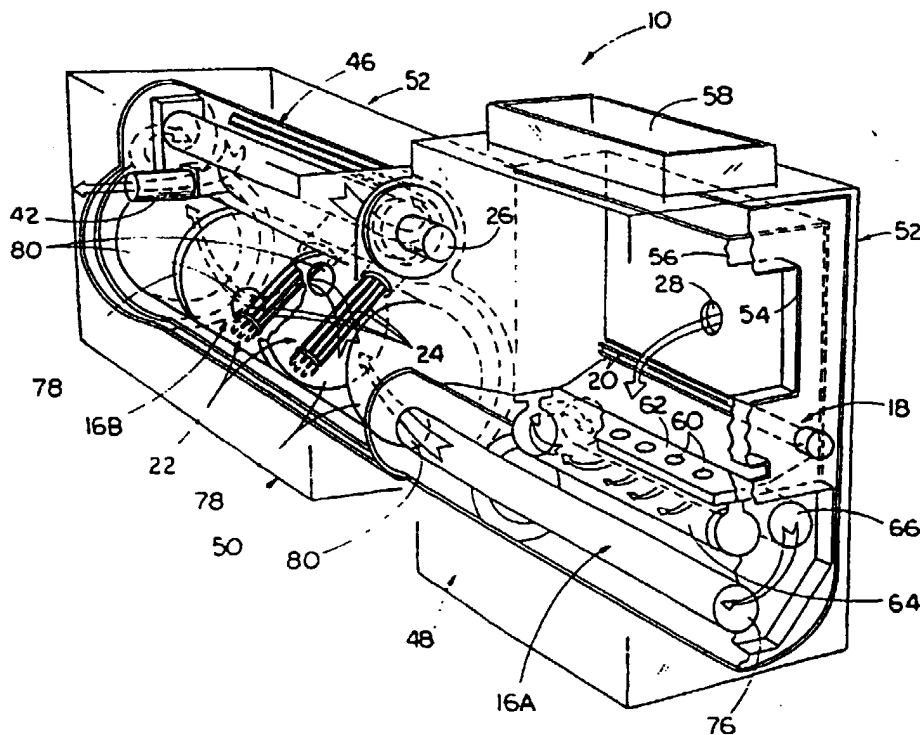
(51) International Patent Classification <sup>5</sup> : <b>F23G 7/00</b>	<b>A1</b>	(11) International Publication Number: <b>WO 94/14007</b>
		(43) International Publication Date: 23 June 1994 (23.06.94)
<p>(21) International Application Number: PCT/US93/11952</p> <p>(22) International Filing Date: 9 December 1993 (09.12.93)</p> <p>(30) Priority Data: 07/987,929 9 December 1992 (09.12.92) US</p> <p>(71)(72) Applicant and Inventor: ESHLEMAN, Roger, D. [US/US]; 506 Clayton Avenue, Waynesboro, PA 17268 (US).</p> <p>(74) Agent: SWARTZ, Michael, R.; 205 Royal Oak Avenue, Pittsburgh, PA 15235 (US).</p>		<p>(81) Designated States: AU, CA, JP, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).</p> <p><b>Published</b> <i>With international search report.</i></p>

(54) Title: MULTIPLE UNIT MATERIAL PROCESSING APPARATUS

## (57) Abstract

A material processing apparatus (10) includes a casing (52) having outer and inner spaced walls (54, 56) forming an airtight vessel (12) inside of the inner wall (56) and a channel (38) between the outer and inner walls (54, 56) surrounding the vessel (12) for containing a flow of coolant fluid. The vessel (12) contains a first chamber (14) having an inlet (58) and a second chamber (16) connected in communication with the first chamber (14) and having an outlet (42). The materials are pyrolyzed in the first chamber (14) and are oxidized in the second chamber (16) and then discharged therefrom. The vessel (12) is separated into first and second units (48, 50) with the first chamber (14) being disposed in the first unit (48). The second

chamber (16) has primary and secondary sections (16A, 16B) for oxidizing materials in two successive stages. The first chamber (14) and the primary section (16A) of the second chamber (16) are disposed in the first unit (48), whereas the secondary section (16B) of the second chamber (16) is disposed in the second unit (50).



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## MULTIPLE UNIT MATERIAL PROCESSING APPARATUS

Technical Field

The present invention generally relates to material processing and, more particularly, is concerned with a multiple unit apparatus for controlled processing of materials, such as the disposal of medical and other waste matter, particularly on-site where the waste matter is produced.

10

Background Art

The problem of disposal of waste matter involves a material processing challenge that is becoming increasingly acute. The primary material processing methods of waste disposal have been burning in incinerators and burial in landfills. These two material processing methods have severe disadvantages. Burning of waste liberates particulate matter and fumes which contribute to pollution of the air. Burial of wastes contributes to the contamination of ground water. A third material processing method is recycling of waste. Although increasing amounts of waste are being recycled, which alleviates the problems of the two primary material processing methods, presently available recycling methods do not provide a complete solution to the waste disposal problem.

The problem of disposal of biomedical waste materials is even more acute. The term "biomedical waste materials" is used herein in a generic sense to encompass all waste generated by medical hospitals, laboratories and clinics which may contain hazardous, toxic or infectious matter whose disposal is governed by more stringent regulations than those covering other waste.

Hospitals and other generators of biomedical waste materials have employed three main material processing methods of waste handling and disposal: (1) on-site incineration with only the residue transferred to landfills; (2) on-site steam autoclaving followed by later transfer of the waste to landfills; and (3) transfer of the waste by licensed hazardous waste haulers to off-site incinerators and landfills. Of

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these three main material processing methods, theoretically at least, on-site disposal is the preferred one.

One recent on-site waste disposal unit which addresses this problem is disclosed in U. S. Patent No. 4,934,283 to Kydd. This unit employs a lower pyrolyzing chamber and an upper oxidizing chamber separated by a movable plate. The waste material is deposited in the lower chamber where it is pyrolyzed in the absence of air and gives off a combustible vapor that, in turn, is oxidized in the upper chamber. While this unit represents a step in the right direction, it does not appear to approach an optimum solution to the problem of biomedical waste material disposal.

#### Disclosure of Invention

The present invention provides a multiple unit material processing apparatus designed to satisfy the aforementioned needs. While the material processing apparatus of the present invention can be used in different applications, it is primarily useful in waste disposal and particularly effective in disposing biomedical waste material on-site where the waste material is produced. A greater than 95% reduction in mass and volume is achieved as is the complete destruction of all viruses and bacteria. The residue is a sterile, inert inorganic powder, which is non-hazardous, non-leachable and capable of disposal as ordinary trash.

Accordingly, the present invention is directed to a material processing apparatus which comprises a casing having outer and inner spaced walls forming an airtight vessel inside of the inner walls and a channel between the outer and inner walls surrounding the vessel for containing a flow of coolant fluid. The vessel contains a first chamber having an inlet and a second chamber connected in communication with the first chamber and having an outlet. The first chamber receives materials through its inlet. The materials are pyrolyzed in the first chamber. The second chamber receives the pyrolyzed materials from the first chamber. The pyrolyzed materials are oxidized in the second chamber and then discharged therefrom. The vessel defined by the casing is separated into first and

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second units. The first chamber of the vessel for pyrolyzing materials is disposed in the first unit. The second chamber of the vessel has primary and secondary sections for oxidizing materials in two successive stages. The first chamber and the primary section of the second chamber are disposed in the first unit, whereas the secondary section of the second chamber is disposed in the second unit.

#### Brief Description of Drawings

10 Fig. 1 is a schematical perspective view of an apparatus for controlled processing of materials including features in accordance with the present invention.

15 Fig. 2 is an enlarged side elevational view of the apparatus of Fig. 1, showing an opposite side from that shown in Fig. 1.

Fig. 3 is an enlarged end elevational view of a first housing unit of the apparatus as seen along line 3--3 of Fig. 2.

20 Fig. 4 is an enlarged opposite end elevational view of the first housing unit of the apparatus as seen along line 4--4 of Fig. 2.

Fig. 5 is an enlarged end elevational view of a second housing unit of the apparatus as seen along line 5--5 of Fig. 2.

25 Fig. 6 is an enlarged opposite end elevational view of the second housing unit of the apparatus as seen along line 6--6 of Fig. 2.

Fig. 7 is a longitudinal vertical sectional view of the apparatus taken along line 7--7 of Fig. 3.

30 Fig. 8 is an enlarged vertical cross-sectional view of the first housing unit of the apparatus taken along line 8--8 of Fig. 7.

Fig. 9 is an enlarged horizontal cross-sectional view of the first housing unit of the apparatus taken along line 9--9 of Fig. 7.

35 Fig. 10 is another horizontal cross-sectional view of the first housing unit of the apparatus taken along line 10--10 of Fig. 7.

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Fig. 11 is still another horizontal cross-sectional view of the first housing unit of the apparatus taken along line 11--11 of Fig. 7.

Fig. 12 is an enlarged vertical cross-sectional view of the second housing unit of the apparatus taken along line 12--12 of Fig. 7.

Fig. 13 is an enlarged foreshortened perspective view of one of the heating units of the apparatus shown in Figs. 8 and 9.

Fig. 14 is an enlarged end elevational view of a deflector device associated with each of the heating units of the first housing unit.

Fig. 15 is a foreshortened front elevational view of the deflector device as seen along line 15--15 of Fig. 14.

Fig. 16 is an enlarged longitudinal elevational view of one of the heating units of the apparatus shown in Fig. 9 of the first housing unit.

Fig. 17 is an end elevational view of the heating unit as seen along line 17--17 of Fig. 16.

Fig. 18 is a cross-sectional view of the heating unit taken along line 18--18 of Fig. 16.

Fig. 19 is another cross-sectional view of the heating unit taken along line 19--19 of Fig. 16.

Fig. 20 is still another cross-sectional view of the heating unit taken along line 20--20 of Fig. 16.

Fig. 21 is a longitudinal sectional view of the heating unit taken along line 21--21 of Fig. 17.

Fig. 22 is a longitudinal vertical sectional view of a modified embodiment of the apparatus.

Fig. 23 is a block diagram of a coolant fluid circulation circuit employed by the apparatus of Fig. 1.

Fig. 24 is a functional block diagram of the material processing apparatus of Fig. 1.

#### Best Mode for Carrying Out the Invention

#### Material Processing Apparatus - In General

Referring now to the drawings, and particularly to

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Figs. 1, 2, 7, 23 and 24, there is illustrated an apparatus, generally designated 10, for controlled processing of materials, and in particular for controlled disposal of biomedical waste materials, which includes features in accordance with the present invention. The material processing apparatus 10 basically includes a coolant jacketed vessel 12 defining a first pyrolysis chamber 14 and a second oxidation chamber 16. The apparatus 10 also includes one or more first heater units 18 having a plurality of elongated rod-like electric heating elements 20 mounted in the vessel 12 and being operable to electrically generate heat for pyrolyzing materials in the first chamber 14, and one or more second heater units 22 having a plurality of electric heating elements 24 mounted in the vessel 12 and being operable to electrically generate heat for oxidizing materials in the second chamber 16.

The apparatus 10 further includes an air flow generating means, preferably an induction fan 26 and a fan speed controller 27, connected in flow communication with the first and second chambers 14, 16, and first and second airflow safety or inlet valves 28, 30 connected to the jacketed vessel 12. The apparatus also includes an air intake proportioning valve 31 connected in flow communication with the first and second air inlet valves 28, 30. The induction fan 26, proportioning valve 31, and first and second inlet valves 28, 30 function to produce separate primary and secondary variable flows of air respectively into and through the first and second chambers 14, 16. One suitable embodiment of the fan speed controller 27 is a commercially-available unit identified as GPD 503 marketed by Magnetek of New Berlin, Wisconsin. One suitable embodiment of the valves 28, 30 is disclosed in U. S. Patent No. 4,635,899, the disclosure of which is incorporated herein by reference thereto. One suitable embodiment of the proportioning valve 31 is a pair of conventional air intake butterfly valves controlled by a standard proportioning motor marketed by the Honeywell Corporation. The respective amounts of air in the primary and secondary flows through the first and second chambers 14, 16 are proportioned by the operation of

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proportioning valve 31 to separately adjust the ratio of the amounts of air flow routed to the first and second air inlet valves 28, 30. The respective amounts of air in the primary and secondary flows are correspondingly varied by varying the speed of operation of the induction fan 26.

Still further at least three temperature sensors 32, 34, 36, such as conventional thermocouples, are mounted on the vessel 12 for sensing the temperatures in the first and second chambers 14, 16 and in the coolant circulating about a channel 38 defined by the jacketed vessel 12 about the first and second chambers 14, 16. Additionally, a gas sensor 40 is mounted on a discharge outlet 42 of the vessel 12 for sensing the concentration of a predetermined gas, for example oxygen, in the discharge gases. Also, a computer-based central control system 44 (Fig. 24) is incorporated in the apparatus 10 for controlling and directing the overall operation of the apparatus 10. One suitable computer which can be employed by the control system 44 is identified as PC-55 marketed by the Westinghouse Electric Corporation of Pittsburgh, Pennsylvania.

Further, as seen in Figs. 7, 12, 23 and 24, the apparatus 10 includes a heat exchanger 46 connected in flow communication between the second chamber 16 and the discharge outlet 42. The heat exchanger 46 functions to remove heat from and thereby cool the coolant flowing through the channel 38 defined by jacketed vessel 12. As pointed out in Figs. 23 and 24, the heat removed by the heat exchanger 46 can be employed in other applications in the facility housing the material processing apparatus 10.

Fig. 24 is a functional block diagram which illustrates the overall relationships between the above-described components of the material processing apparatus 10. Fig. 24 also illustrates the directions of interactions between the components of the apparatus 10 under the monitoring and control of its computer-based central control system 44 for effecting optimal pyrolyzing and oxidizing of the materials therein. The material processing apparatus 10 operates through one cycle to process, that is, to pyrolyze and oxidize, a predetermined batch of material, such as biomedical waste material.



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More particularly, the control system 44 is responsive to the temperatures sensed in the first and second chambers 14, 16 by temperature sensors 32, 34 and in the coolant circulating through the channel 38 of the jacketed vessel 12 by temperature sensor 36. The control system 44 also is responsive to the proportion of the predetermined gas, such as oxygen, sensed in the discharge gases by gas sensor 40. The control system 44, in response to these various temperatures sensed and to the proportion of oxygen sensed, operates to control the position of the air intake proportioning valve 31 so as to adjust the ratio of or proportion the amount of primary air flow to the amount of secondary air flow through the first and second inlet valves into the first and second chambers 14, 16. Also, the control system 44, in response to these various temperatures sensed and to the proportion of oxygen sensed, operates to control the operation of the induction fan 26 via the fan speed controller 27 so as to adjust the amounts (but not the proportion) of primary and secondary air flows into the first and second chambers 14, 16.

20

#### Multiple Unit Material Processing Apparatus

For many applications, the material processing apparatus 10 can be provided in the form of a single unit where all components of the apparatus are contained within the one unit. However, in order to accommodate space and installation requirements, there are other applications where the material processing apparatus 10 needs to be provided in the form of two separate first and second units 48, 50, as shown in Figs. 1-12. For example, in some hospital sites, the provision of the apparatus 10 as two separate units 48, 50 permits the apparatus 10 to be transported through existing doorways and hallways and installed in existing rooms. Figs. 1-12 illustrate an embodiment of the apparatus 10 wherein the first and second units 48, 50 are disposed in end-to-end relation to one another. Fig. 22 illustrates another embodiment of the apparatus 10 wherein the first and second units 48, 50 are disposed one (first) unit 48 above the other (second) unit 50.

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Referring to Figs. 1-12, the material processing

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apparatus 10 includes a casing 52 having outer and inner spaced walls 54, 56 forming the coolant jacketed airtight pressure vessel 12 inside of the inner wall 56 and the channel 38 between the outer and inner walls 54, 56. The channel 38 surrounds the vessel 12 and contains the flow of coolant fluid, such as water. Fig. 23 illustrates an example of the circulation flow path of the coolant fluid about the vessel channel 38 and between the first and second units 48, 50 of the vessel 12. As mentioned above, the vessel 12 of the apparatus 10 is separated into first and second units 48, 50 and has means in the form of a pair of tubular extensions 54A, 56A of the outer and inner walls 54, 56 which are fastened together to interconnect the first and second units 48, 50 in flow communication with one another.

Referring to Figs. 7-11, the vessel 12 defines the first pyrolysis chamber 14 having an inlet 58 and the second oxidation chamber 16 connected in communication with the first pyrolysis chamber 14 and having the discharge outlet 42. The first chamber 14 in which the materials will be pyrolyzed receives the materials through the inlet 58 via operation of an automatic feeding system 59 (Fig. 24). The first chamber 14 of the vessel 12 for pyrolyzing materials is disposed in the first unit 48. The material, through pyrolysis, or burning in a starved oxygen atmosphere, is converted to a gas that exits the first chamber 14 by passing down through holes 60 in fire brick 62 in the bottom of the first chamber 14 and therefrom to the second chamber 16.

The second chamber 16 receives the pyrolyzed materials from the first chamber 14 and, after oxidizing the pyrolyzed materials therein, discharges the oxidized materials therefrom through the discharge outlet 42. The second chamber 16 has primary and secondary sections 16A, 16B for oxidizing materials in two successive stages. The primary section 16A is disposed in the first unit 48 of the vessel 12 between the first chamber 14 and the tubular extensions 54A, 56A. The secondary section 16B is disposed in the second unit 50 of the vessel 12.

The primary section 16A of the second chamber 16 contains a series of serpentine passages or tunnels 64, 66, 68

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defined in a mass 70 of refractory material contained in the first unit 48. The gas passes in one direction through the center tunnel 64 which is plugged at one end, then in reverse direction toward the rear of the first unit 48 to a rear manifold 72, then splits into two gas flows and again reversing in direction to pass toward the front of the first unit 48 through the opposite side tunnels 66, 68 (on the opposite sides of the plugged center tunnel 64), and then to a front manifold 74 where the oxidized gas passes down to a lower tunnel 76.

10 The secondary section 16B of the second chamber 16 is located in the second unit 50. The oxidized gas from the primary section 16A of the second chamber 16 flows through the lower tunnel 76 in a direction toward the rear of the first unit 48, through the tubular extensions 54A, 54B, and into the secondary section 16B in the second unit 50. The secondary section 16B has a series of spaced air flow baffles 78 with offset openings 80 extending across the flow path of air through secondary section 16B.

The heat exchanger 46 is also located in the second unit 20 50 above the secondary section 16B of the second chamber 16. The upper heat exchanger 46 has the induction fan 26 connected at one end which operates to draw the gases from the first chamber 14 down through the fire brick 62 into the primary section 16A of the second chamber 16. The gases then flow 25 through the tunnels 64, 66, 68 of the primary section 16A, back through the secondary section 16B of the second chamber 16, then up and forwardly through the center of the heat exchanger 46 to the center of the induction fan 26 which then forces the exhaust gas outwardly and rearwardly around and along the heat 30 exchanger 46 for exiting through discharge outlet 42 into a wet scrubber 82 (Fig. 24). The exhaust gas is virtually free of any pollution and the original material has been almost completely oxidized so that only a very small amount of fine minute dust or powder particles are collected in a particle 35 separator (not shown).

#### Heat Generator Assembly

Referring to Figs. 1, 7-9, 13-21, 23 and 24, there is

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illustrated a pair of heat generator assemblies 84 incorporated in the first chamber 14 of the apparatus 10. The heat generator assemblies 84 are mounted horizontally through the first chamber 14 and adjacent opposite side portions of the inner wall 56 of the casing 52. Each heat generator assembly 84 includes the first heater unit 18 and an elongated deflector structure 86 mounted adjacent to and along the electric heating elements 20 of the first heating unit 18. The first heater unit 18 is mounted to the vessel 12 and extends horizontally into the first chamber 14 between opposite ends thereof and along one of the opposite sides thereof. The first heater unit 18 is powered by a power controller 87 (Fig. 24) which, in turn, is powered by an electrical power supply (not shown) and controlled by the computer-based control system 44 for producing heating of materials received in the first chamber 14 to cause pyrolyzing of the materials into gases. One suitable embodiment of the power controller 87 is a commercially-available unit identified as SSR2400C90 marketed by Omega Engineering of Stamford, Connecticut. The plurality of elongated electric heating elements 20 extend in generally parallel relation to one another and are constructed of electrically-resistive material operable for emitting heat radiation. The deflector structure 86 extends in circumferential relation partially about the electric heating elements 20 so as to deflect the heat radiation in a desired direction away from the electric heating elements 20 and from the adjacent side of the first chamber 14.

Referring to Figs. 13-21, in addition to the electric heating elements 20, each first heater unit 18 includes an elongated support member 88 having spaced opposite end portions 88A, 88B, a pair of elongated electrically-conductive positive and negative electrodes 90, 92 each having spaced opposite end portions 90A, 90B and 92A, 92B, and an electrically insulative cylindrical mounting body 94 sealably mounted through the outer and inner walls 54, 56 at the front of the first unit 48 of the casing 52 and supporting the support member 88 and electrodes 90, 92 at corresponding ones of the opposite end portions 88A, 90A, 92A thereof so as to position the support member 88 and

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electrodes 90, 92 in spaced apart and substantially parallel relation to one another. The one end portions 90A, 92A of the positive and negative electrodes 90, 92 project from the exterior of the front of the casing 52 such that they can be  
5 electrically connected to the power supply (not shown) and the control system 44.

Each first heater unit 18 further includes a plurality of spacer elements 96, in the form of electrically-insulative circular discs 96, supported along the support member 88 in  
10 spaced relation from one another. The support member 88 includes an elongated rod 98 and a plurality of ceramic sleeves 100 inserted over the rod 98. The sleeves 100 are disposed between the spacer discs 96, positioning them in the desired spaced relationship. The ceramic sleeves 100 and spacer discs  
15 96 are maintained in the desired assembled condition by nuts 102 tightened on the threaded opposite end portions 98A, 98B of the elongated rod 98 of the support member 88. The one end portion 98A of the rod 98 extends through and is supported by the cylindrical mounting body 94, while the other end portion  
20 98B of the rod 98 is supported upon a bracket 104 fixed on the inner wall 56 at a rear end of the first unit 48 of the casing 52.

The spacer discs 96 support the elongated electric heating elements 20 and positive and negative electrodes 90, 92  
25 at spaced locations therealong so as to position the electric heating elements 20 in spaced apart and substantially parallel relation to one another and to the positive and negative electrodes 90, 92 and in an arcuate configuration between the positive and negative electrodes 90, 92 and offset from the  
30 support member rod 98. Each spacer disc 96 has an array of holes 106 arranged in asymmetrical relation to a center C of the disc permitting the passage therethrough of the positive and negative electrodes 90, 92 and the electric heating elements 20. Preferably, the electric heating elements 20 and  
35 electrodes 90, 92 are spaced along about an 180° arc of a circle. In such manner, the heat energy radiated by the electric heating elements 20 is concentrated and directed on the material and not on the portion of the inner wall 56 of the

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casing 52 adjacent to the heater unit 18.

The first heating unit 18 also includes means in the form of a plurality of short rod-like connector elements 108 made of electrically-conductive material which electrically connects  
5 selected ones of the opposite end portions 20A, 20B of the electric heating elements 20 with selected ones of the opposite end portions 90A, 90B and 92A, 92B of the positive and negative electrodes 90, 92 so as to define an electrical circuit path, having a substantially serpentine configuration,  
10 between the positive and negative electrodes 90, 92 and through the electric heating elements 20. The rod-like connector elements 108 are interspaced between and rigidly attached to the selected ones of the opposite end portions of the electric heating elements 20 and the positive and negative  
15 electrodes 90, 92.

Each of the second heater units 22 employed in the secondary section 16B of the second chamber 16 has substantially the same construction and configuration as the first heater unit 18 described above with one difference. The  
20 difference is that the electric heating elements 24 of the second heater unit 22 are distributed and spaced about the full circle instead of only about one-half of the circle. The second heater units are also powered by another power controller 87.

25 Thus, the first heater units 18 in the first chamber 14 are specifically designed and positioned so that the electric heating elements 20 are disposed away from the side portions of the inner wall 54 of the vessel 12. The deflector structure 86 associated with each first heater unit 18 serves to deflect the  
30 flow of gases away from the electric heating elements 20 and thus protect them from damage and also serve to direct the heat radiated by the electric heating elements 20 away from the inner wall 56. The deflector structure 86 includes a planar mounting plate 110 attached to the adjacent side portion of the  
35 inner wall 56, an arcuate shield 112 extending along the mounting plate 110, and means in the form of one or more braces 114 rigidly attaching the arcuate shield 112 along the mounting plate 110. The arcuate shield 112 overlies and surrounds

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approximately the upper one-third, or  $120^{\circ}$ , of the circular heater unit 18.

#### Casing And Heater Configuration

5 Referring to Figs. 1, 5-7 and 12, as described earlier the second unit 50 of the casing 52 includes therein the lower secondary section 16B of the second chamber 16 and the upper heat exchanger 46. Also, the secondary section 16B of the second chamber 16 includes a plurality, for example three, of  
10 the second heater units 22 and the baffles 78.

In order to provide access from the exterior of the casing 52 for mounting the second heater units 22 through spaced side portions of the outer and inner walls 54, 56 of the casing 52 and within the second chamber 16, the outer wall 54  
15 of the second unit 50 of the casing 52 has a unique configuration. The outer wall 54 has a substantially one-sided figure eight configuration so as to accommodate positioning of the second heater units 22 through the spaced side portions of the outer and inner walls 54, 56 of the casing 52 to extend  
20 across the second chamber 16 in orientations positioned intermediately, such as about  $45^{\circ}$ , between vertical and horizontal orientations.

Further, in the second unit 50 the inner wall 56 of the casing 52 is provided in the form of a plurality of upper inner  
25 walls 116, 118, 120, 122 having substantially concentric cylindrical configurations, and a lower inner wall 124. The concentric upper inner walls 116, 118, 120, 122 define an upper airtight portion of the vessel 12 which, in turn, defines the heat exchanger 46. The lower inner wall 124 defines a lower  
30 airtight portion of the vessel 12 which contains the secondary section 16B of the second chamber 16.

An inner manifold 126 is defined at the rear end of the second unit 50 of the casing 52 between the outer wall 54 and the rear end portions of the concentric inner walls 116, 118,  
35 120, 122 so as to provide extension 38A of the channel 46 into the heat exchanger 46 for providing flow communication of the coolant through the heat exchanger 46. An outer manifold 128 is defined also at the rear end of the second unit 50 of the

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casing 52 for providing flow communication of gases from the secondary section 16B of the second chamber 16 through the heat exchanger 46 to the discharge outlet 42.



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CLAIMS

1. A material processing apparatus, comprising:

5 (a) a casing having outer and inner spaced walls forming an airtight vessel inside of said inner walls and a channel between said outer and inner walls surrounding said vessel for containing a flow of coolant fluid;

10 (b) said vessel containing a first chamber having an inlet and a second chamber connected in communication with said first chamber and having an outlet, said first chamber for receiving and pyrolyzing materials therein, said second chamber for oxidizing pyrolyzed materials therein and discharging pyrolyzed and oxidized materials therefrom;

15 (c) said casing being defined by separate first and second units spaced from one another and means extending between and interconnecting said spaced first and second units for defining a flow communicating passage between said first and second units;

20 (d) said first chamber of said vessel for receiving and pyrolyzing materials being disposed in said first unit, said second chamber of said vessel having primary and secondary sections for oxidizing materials in two successive stages, said primary section of said first chamber being disposed in said first unit between said first chamber and said flow communicating passage defining means, said secondary section of  
25 said second chamber being disposed in said second unit;

30 (e) means mounted to said vessel and communicating with said first and second chambers for producing primary and secondary one-way flows of air into and through said first and second chambers and from said first unit through said flow communicating passage defining means and into said second unit; and

35 (f) means coupled to said primary and secondary one-way air flow producing means for controlling the operation thereof to proportion the respective amounts of primary and secondary one-way air flows into and through said first and second chambers and from said first unit to said second unit through said flow communicating passage defining means.

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2. The apparatus as recited in Claim 1, wherein said primary section of said second chamber includes a series of interconnected serpentine passages.

5        3. The apparatus as recited in Claim 1, wherein said secondary section of said second chamber has a series of spaced air flow baffles extending across the flow path of air through said secondary section.

10       4. The apparatus as recited in Claim 1, further comprising:

         at least one first heater unit mounted to said vessel and extending into said first chamber and being operable for producing heating of materials received therein to cause  
15       pyrolyzing of the materials into fluids.

5. The apparatus as recited in Claim 4, wherein said first heater unit includes a plurality of elongated electric heating elements extending in generally parallel relation to one another and being operable for emitting heat radiation.

6. The apparatus as recited in Claim 4, further comprising:

         at least one second heater unit mounted to said vessel and extending into said second chamber and being operable for producing heating of fluids therein to cause oxidizing of the fluids into discharge gases.

7. The apparatus as recited in Claim 1, wherein said first and second units are disposed one unit above the other unit.

8. The apparatus as recited in Claim 1, wherein said first and second units are disposed in end-to-end relation to one another.

9. The apparatus as recited in Claim 1, wherein said primary and secondary one-way air flow producing means

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includes:

an air flow generating means mounted to said second unit and connected in flow communication with said second chamber for generating a lower pressure in said secondary section of said second chamber than in said first chamber and said primary section of said second chamber;

first air flow regulating means mounted to said first unit and connected in flow communication with said first chamber for controlling said primary flow of air through said first chamber; and

second air flow regulating means mounted to said first unit and connected in flow communication with said primary section of said second chamber for controlling said secondary flow of air through said primary and secondary sections of said second chamber.

10. The apparatus as recited in Claim 1, wherein said air flow controlling means is operable to proportion the respective amounts of primary and secondary air flows through said first and second chambers by varying operation of said air flow generating means and said first and second air flow regulating means.

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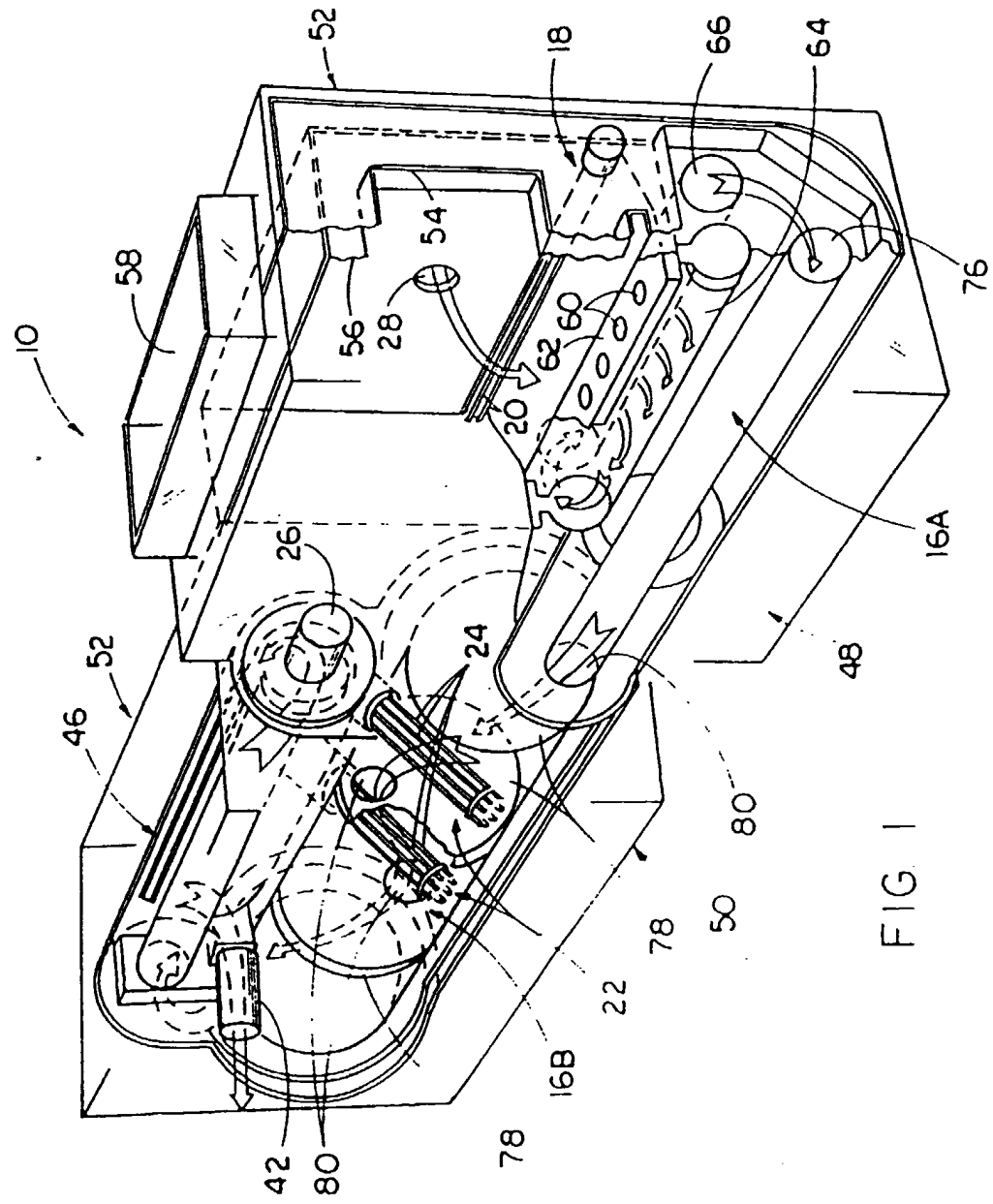
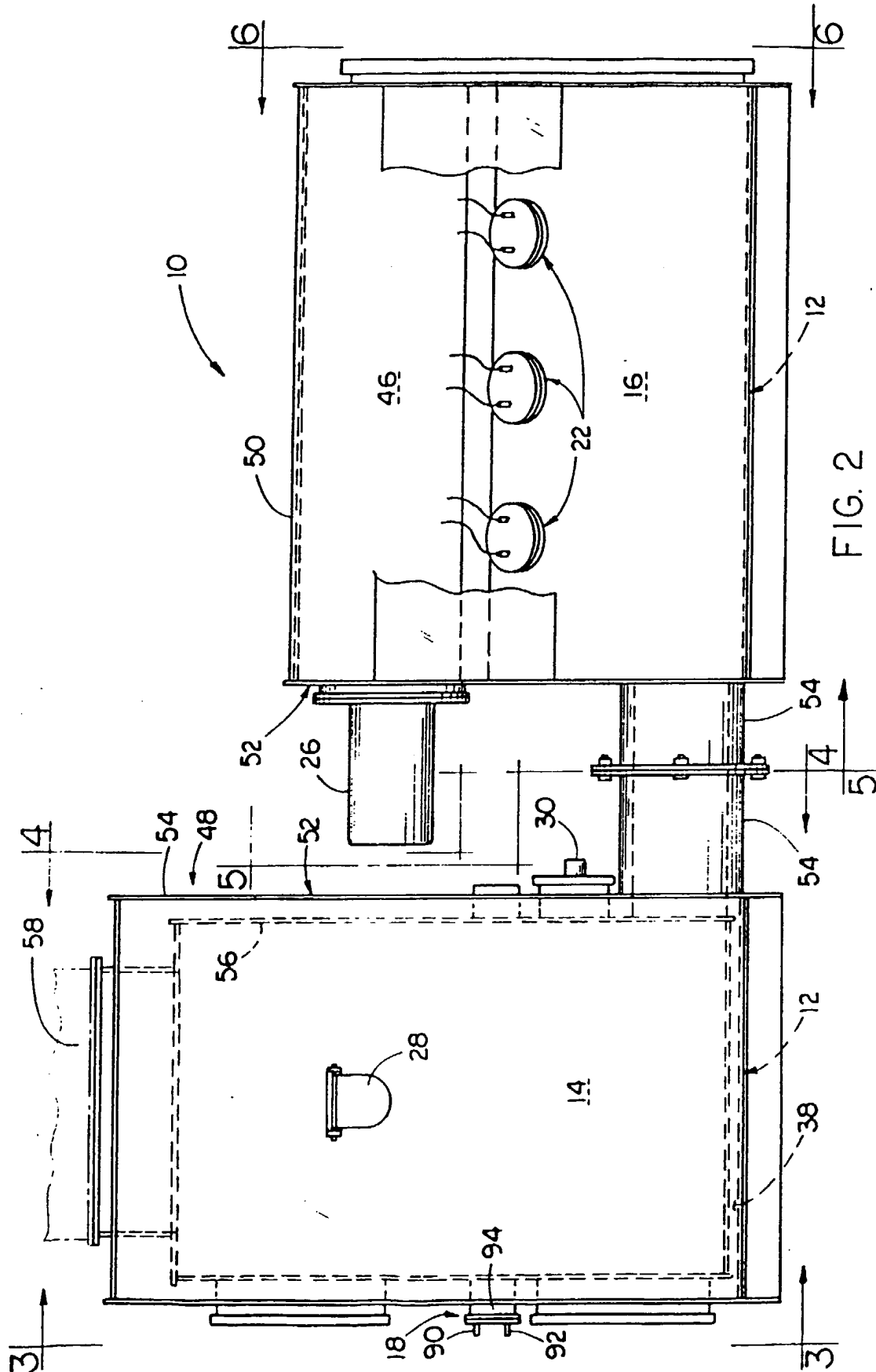


FIG. 1

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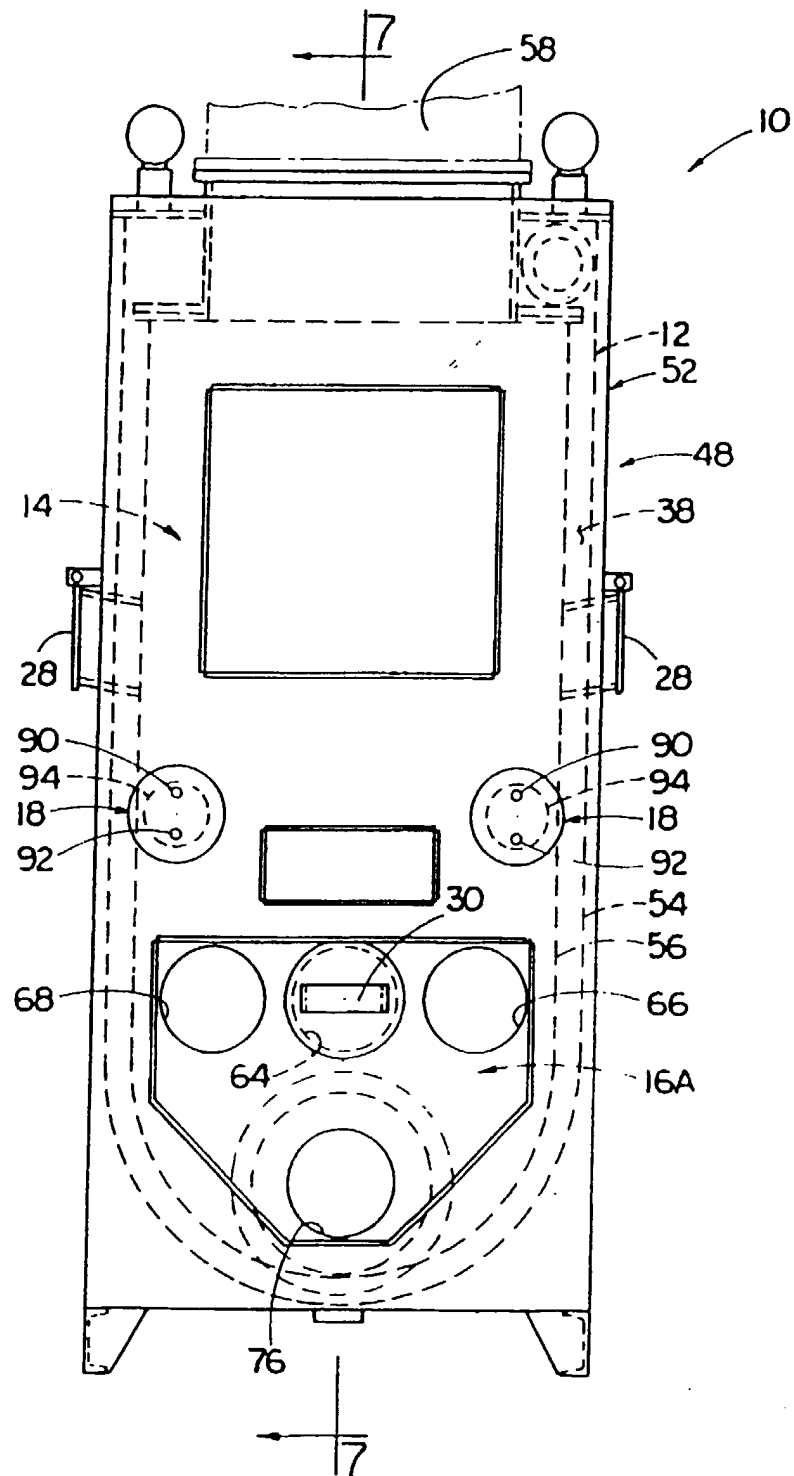


FIG. 3

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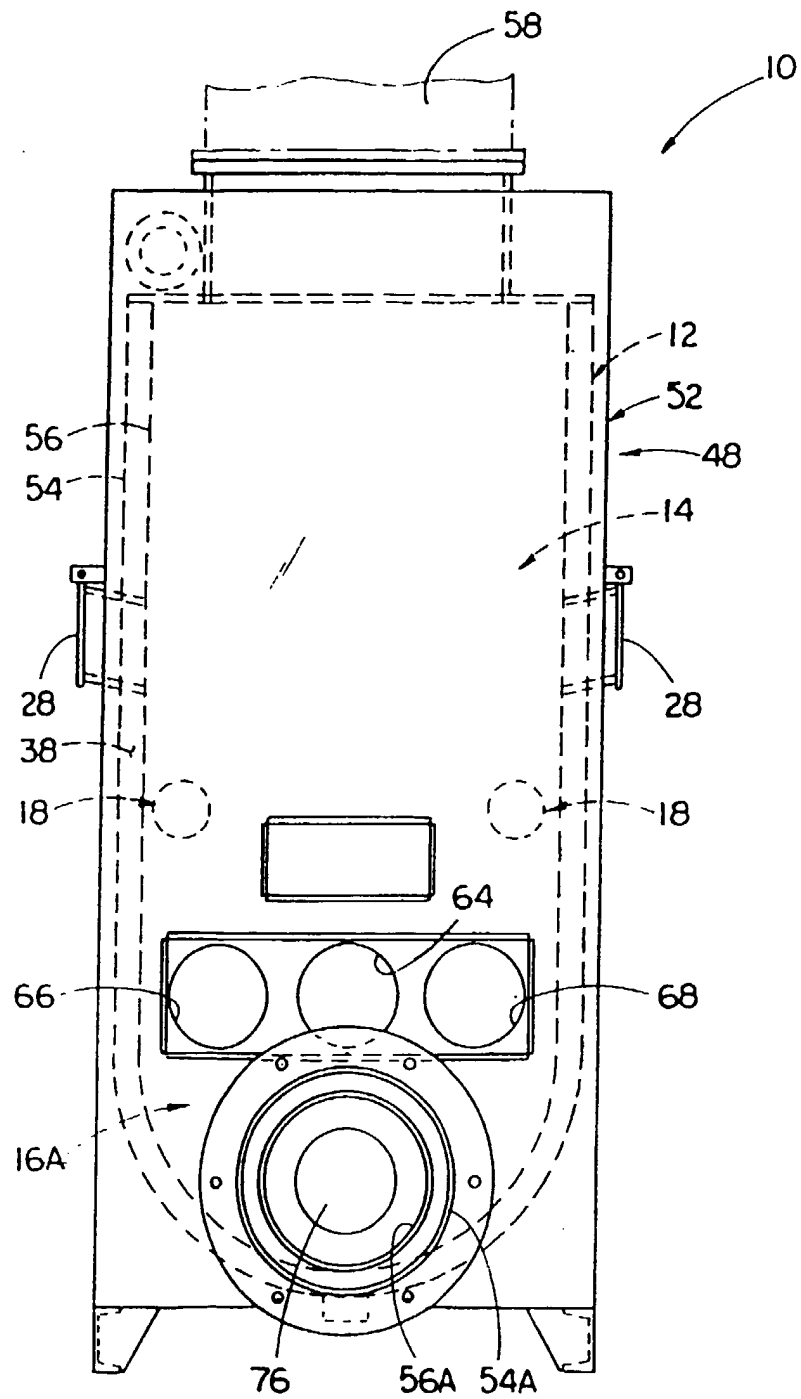


FIG. 4

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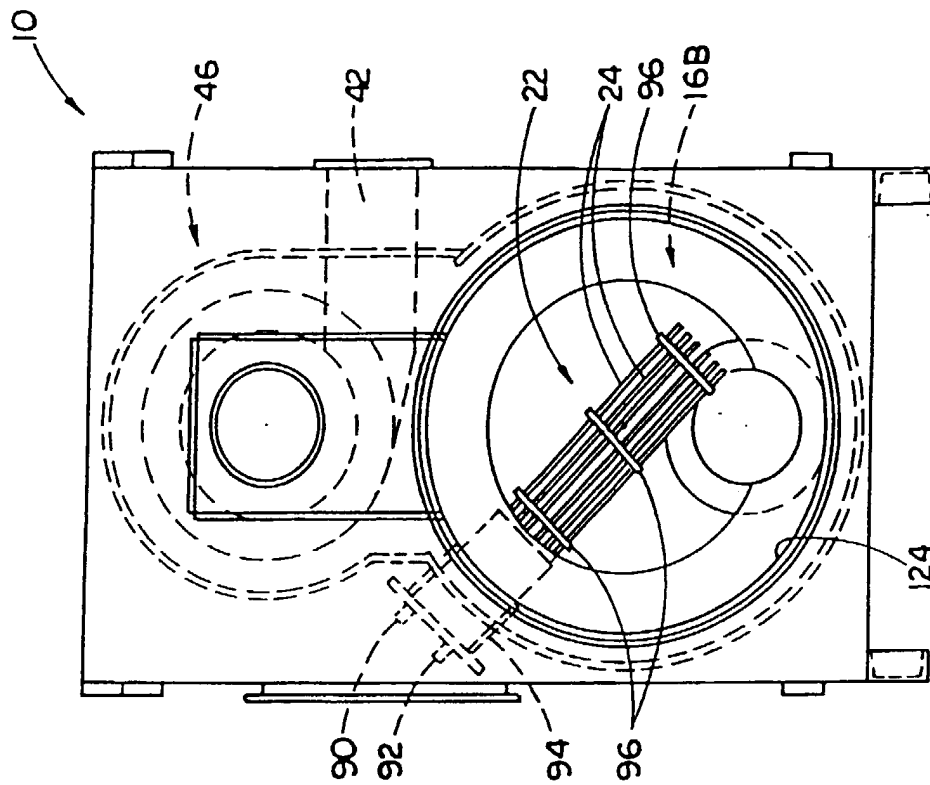


FIG. 5

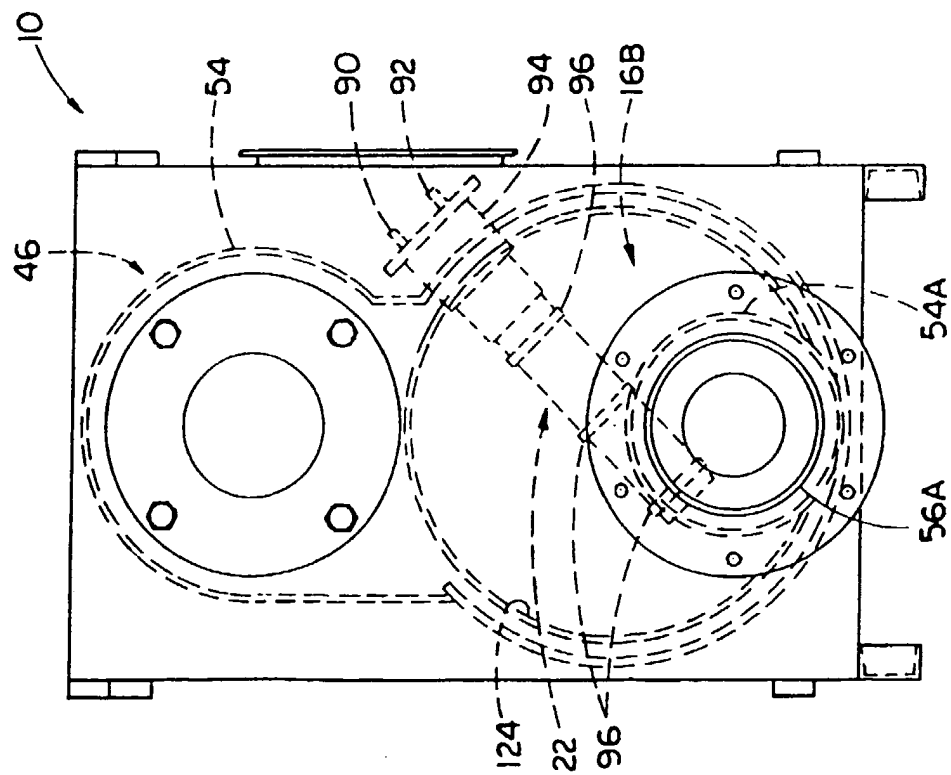
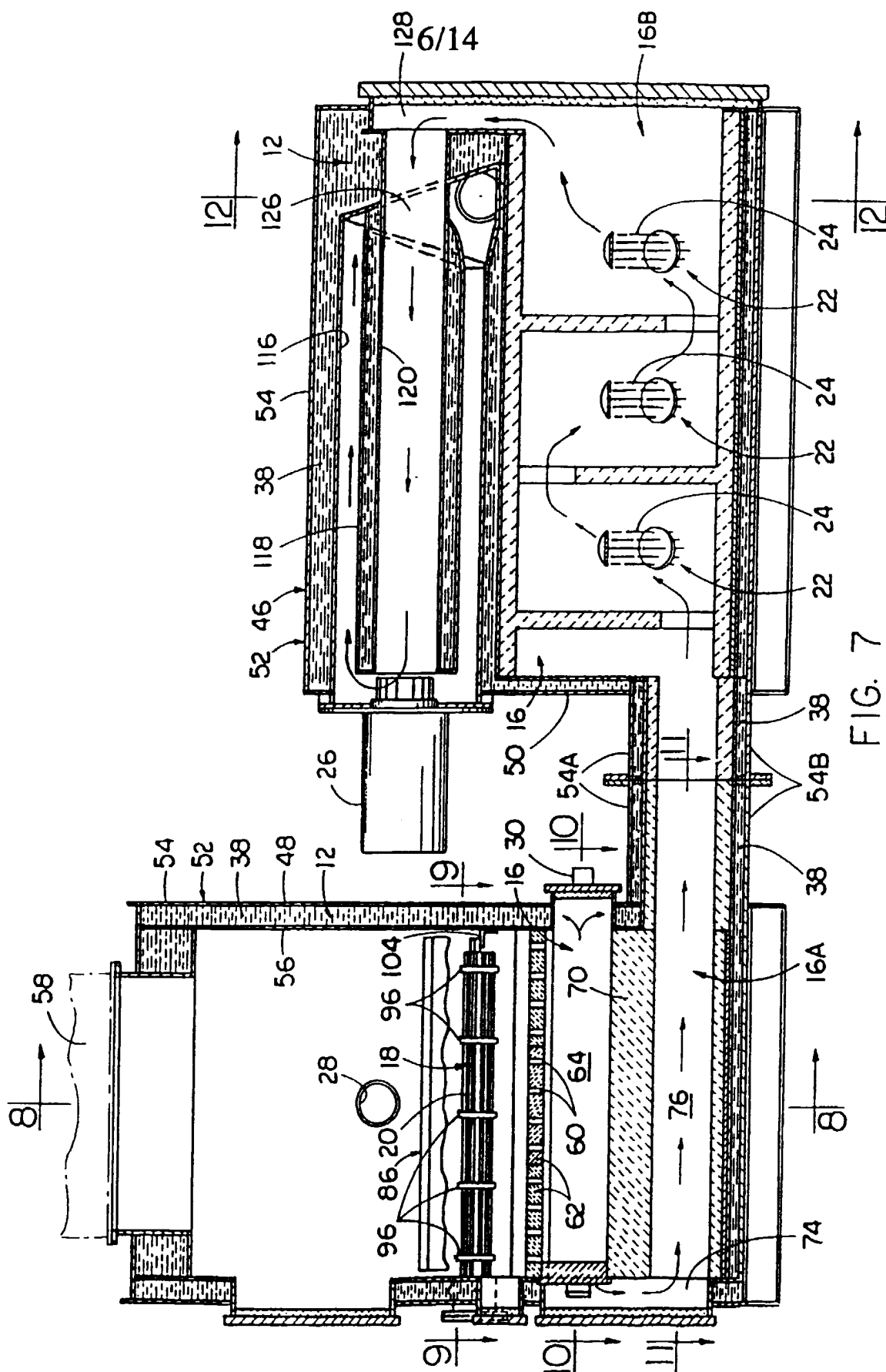


FIG. 6





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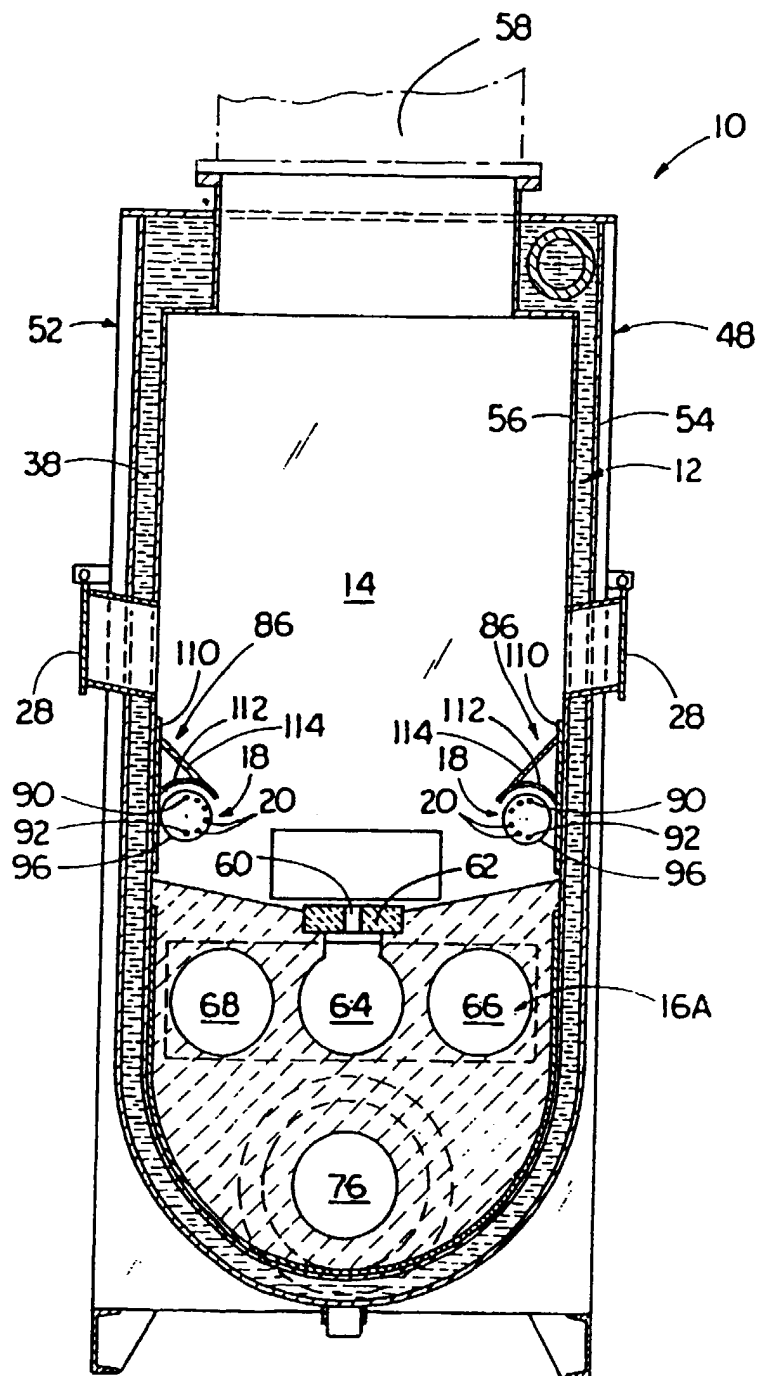
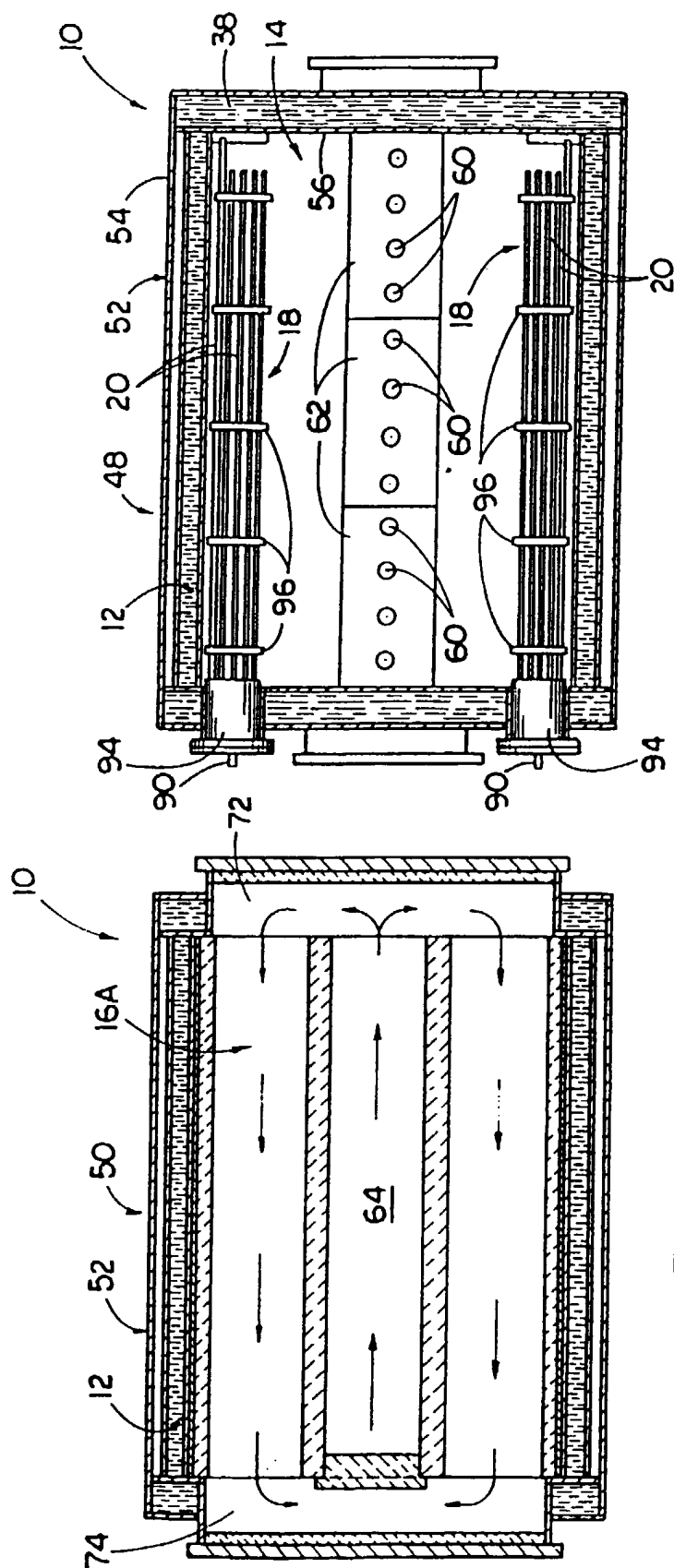


FIG. 8

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FIG. 10

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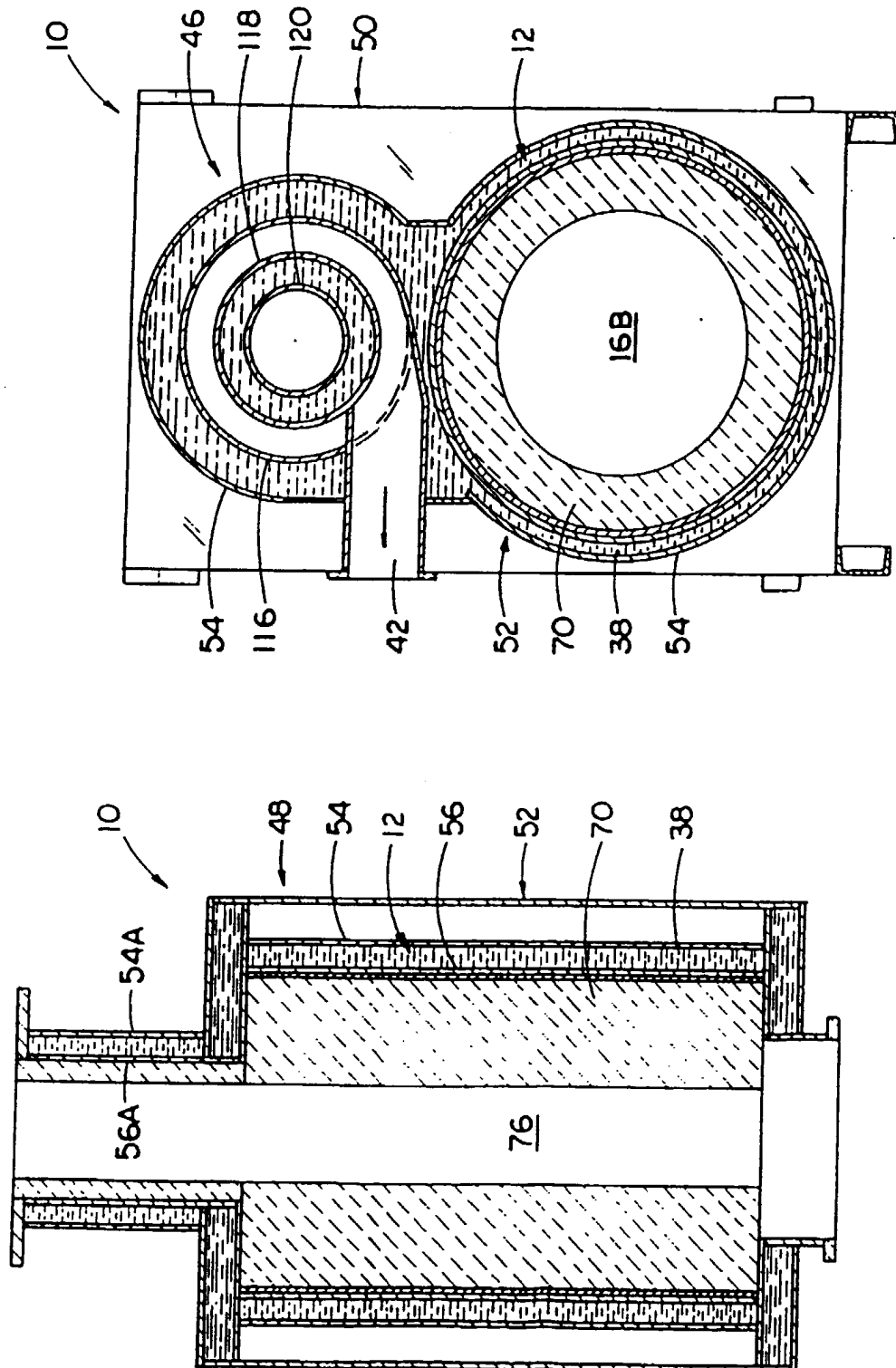


FIG. 12

FIG. 11



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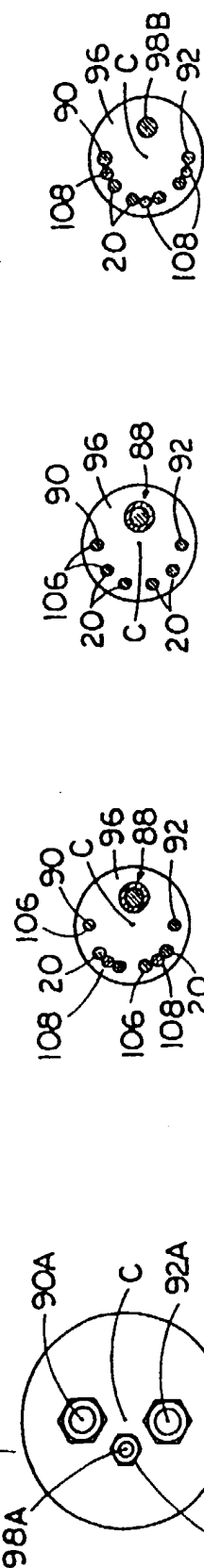
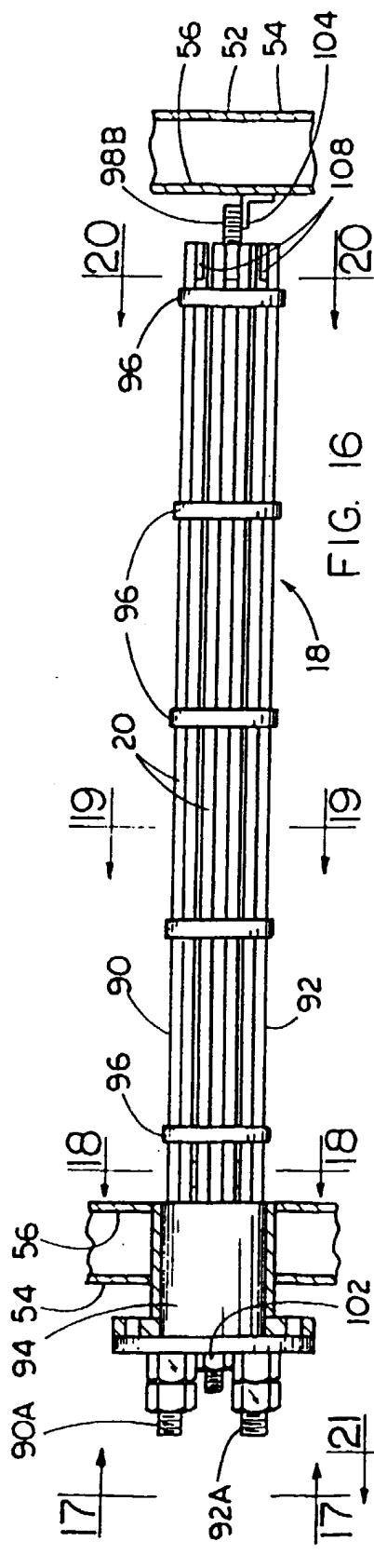
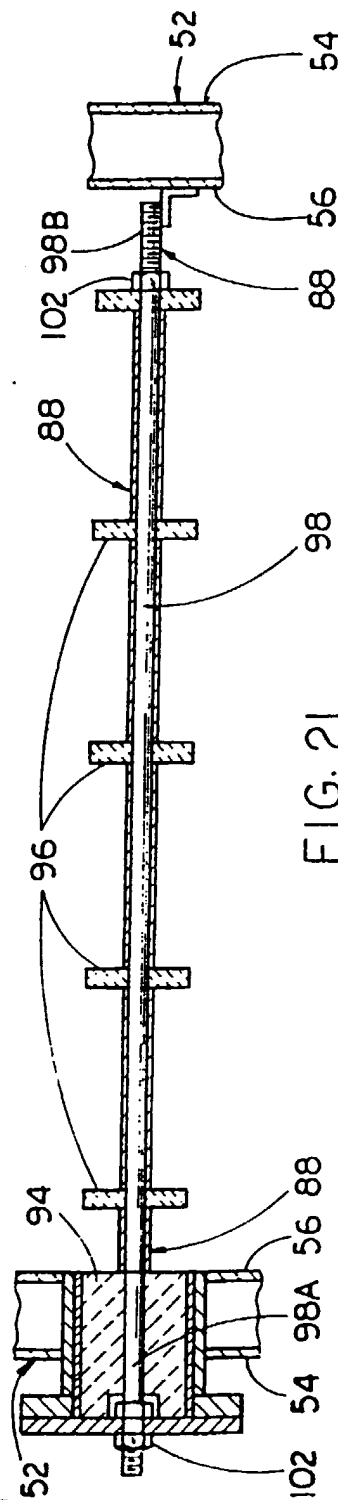


FIG. 20



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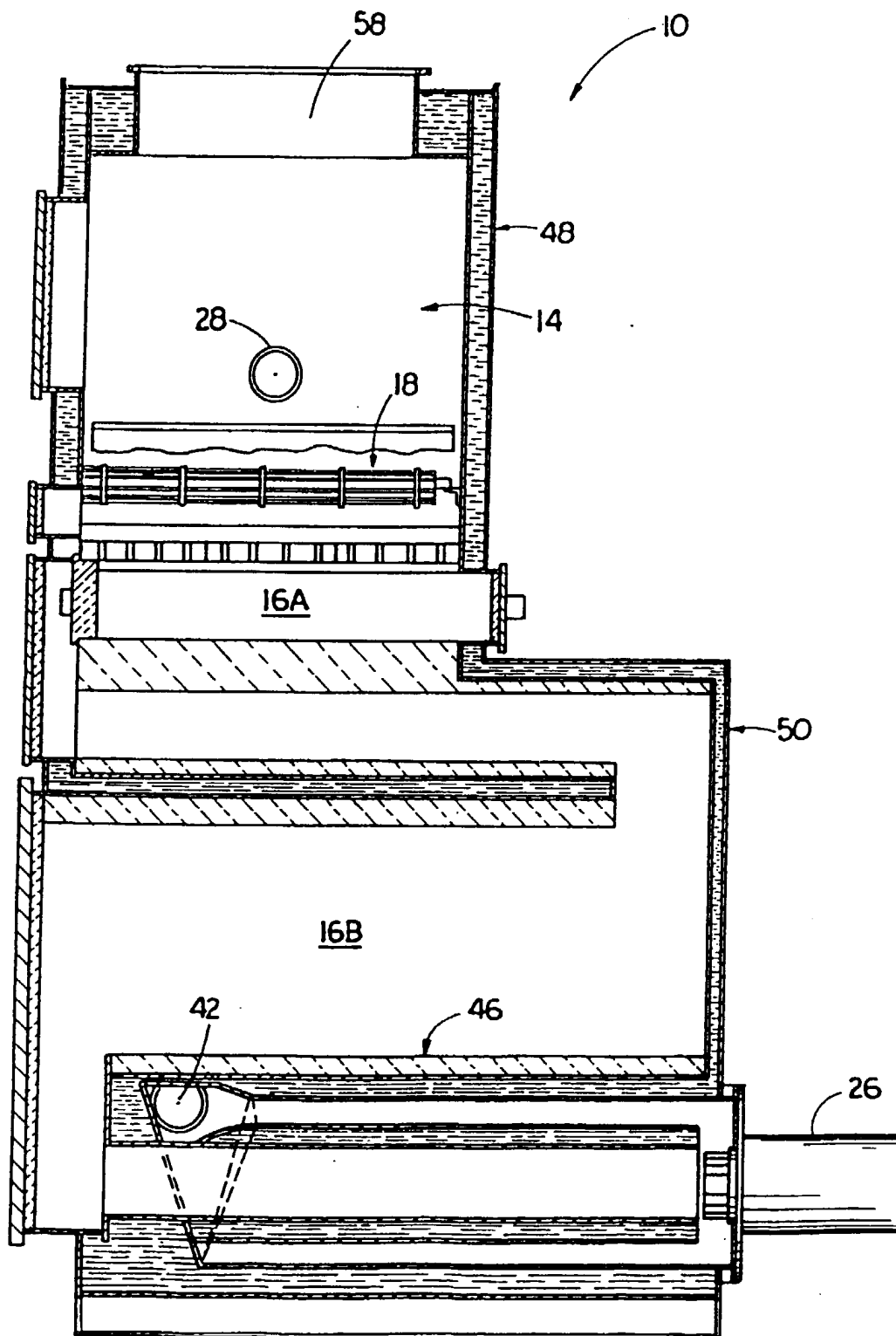


FIG. 22

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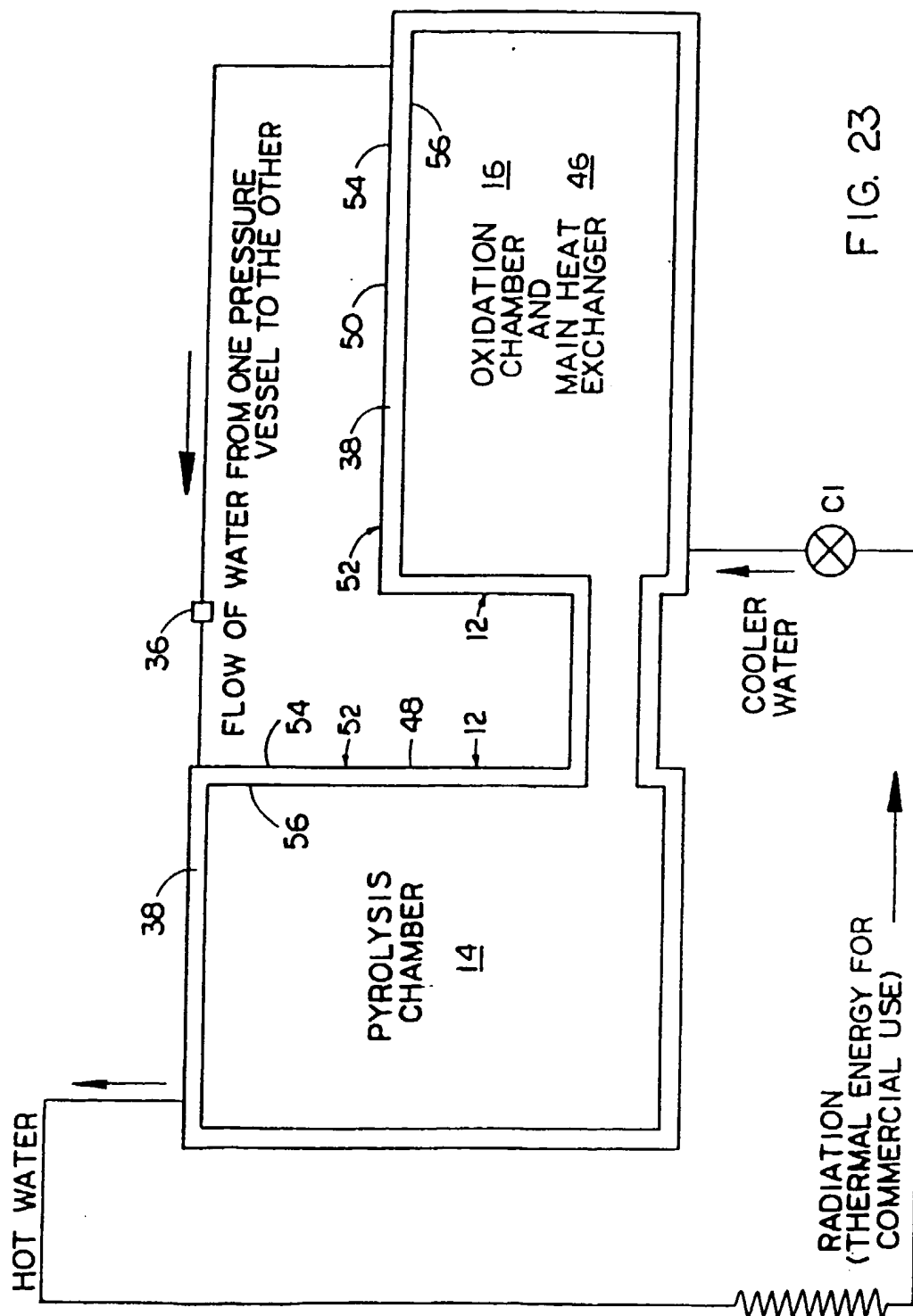


FIG. 23



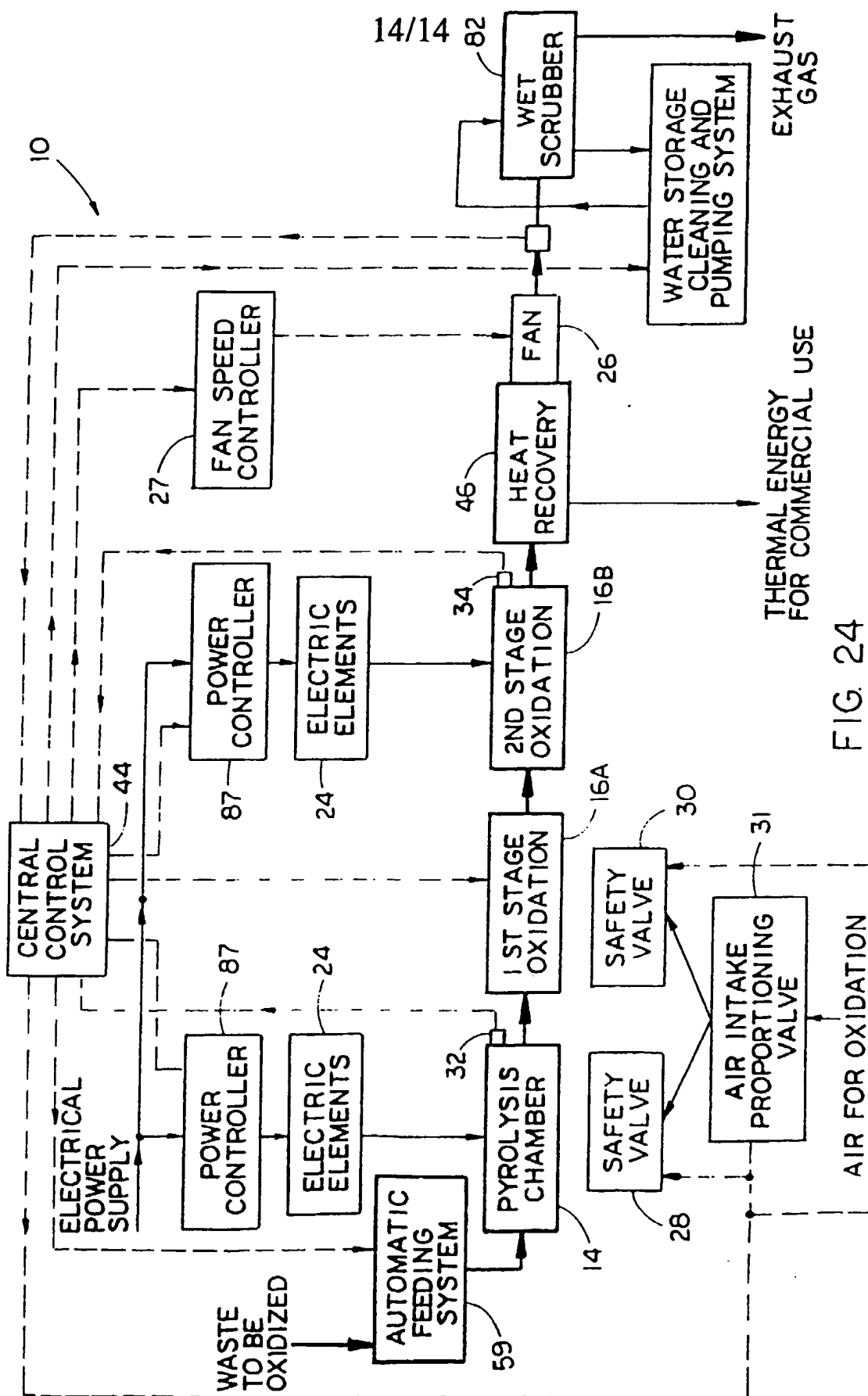
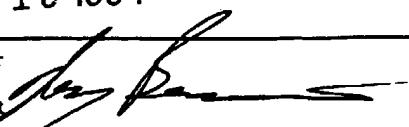


FIG. 24

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US93/11952

<b>A. CLASSIFICATION OF SUBJECT MATTER</b>																				
IPC(5) : F23G 7/00 US CL : 110/235 According to International Patent Classification (IPC) or to both national classification and IPC																				
<b>B. FIELDS SEARCHED</b>																				
Minimum documentation searched (classification system followed by classification symbols) U.S. : 110/235, 250,346,188,234,322,326																				
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched																				
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)																				
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>																				
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.																		
A	US, A, 1,764,553 (Epstein) 17 June 1930, see entire document.	1-10																		
A	US, A, 3,636,896 (McLaren et al) 25 January 1972, figures 1,5 and 7.	2,3																		
A	US, A, 4,304,396 (Udoh) 08 December 1981, see entire document.	1-10																		
A	US, A, 4,926,797 (Butler) 22 May 1990, see entire document.	1-10																		
A	US, A, 4,934,283 (Kydd) 19 June 1990, see entire document.	1-10																		
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.																				
<table border="0"> <tr> <td>* Special categories of cited documents:</td> <td>"T"</td> <td>later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</td> </tr> <tr> <td>"A" document defining the general state of the art which is not considered to be part of particular relevance</td> <td>"X"</td> <td>document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</td> </tr> <tr> <td>"E" earlier document published on or after the international filing date</td> <td>"Y"</td> <td>document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</td> </tr> <tr> <td>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</td> <td>"Z"</td> <td>document member of the same patent family</td> </tr> <tr> <td>"O" document referring to an oral disclosure, use, exhibition or other means</td> <td></td> <td></td> </tr> <tr> <td>"P" document published prior to the international filing date but later than the priority date claimed</td> <td></td> <td></td> </tr> </table>			* Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention	"A" document defining the general state of the art which is not considered to be part of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone	"E" earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art	"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Z"	document member of the same patent family	"O" document referring to an oral disclosure, use, exhibition or other means			"P" document published prior to the international filing date but later than the priority date claimed		
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"E" earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art																		
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"O" document referring to an oral disclosure, use, exhibition or other means																				
"P" document published prior to the international filing date but later than the priority date claimed																				
Date of the actual completion of the international search 08 February 1994		Date of mailing of the international search report <b>MAR 15 1994</b>																		
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. NOT APPLICABLE		Authorized officer Henry Bennett  Telephone No. (703) 308-0101																		